DER ROADSHOW

Distributed
Energy
Resources

Distributed Generation Grid Interconnection

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DER ROADSHOW
APRIL 2003
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DG Interconnection

Distributed Energy Resources

- Discussion Topics
  - Distributed Energy Resources
  - DG Modes of Operation
  - DG Technologies
  - Application Considerations
  - DG Value
  - Changing Grid
  - Changing Codes & Rules
  - Summary

Distributed Energy Resources

Distributed Energy Resources

- *Not a new concept*
  - *Power Plants are distributed*
- *Has been around for decades*
  - *Industrial cogeneration*
  - *Large power users*
- *What's new is size, technology, & location*
  - *1 kw to 10 MW*
  - *Distribution circuits*

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DER Modes of Operation

- Emergency
  - Disconnected from grid when the grid is de-energized.
  - Usually a break-before-make transfer switch
  - NFPA 70
  - NEC 700 – Emergency Systems
  - NEC 701 – Legally Req'd Standby Systems

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DER Modes of Operation

- Isolated
  - Disconnected from grid with the grid energized
  - Hourly pricing, interruptible
  - May be
    - » make before break (Synch Check)
    - » or break before make (ATS Blink)
  - NFPA 70
  - NEC 700 Emergency Systems
  - NEC 705 Interconnected Electrical Power Production Sources
  - ANSI / IEEE 242 Protective Devices

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DER Modes of Operation

- Base Loaded
  - Connected to grid with power output
  - Cogeneration system
  - No transfer switch – Parallel Swgr
  - May have transfer trip provisions
  - Grid supplies supplemental power
  - NFPA 70
  - NEC 705 Interconnected Electrical Power Production Sources
  - ANSI / IEEE 242 Protective Devices

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DER Modes of Operation

- Peak Shaving
  - Connected to grid
  - Variable power output
  - Make before break ATS – Synch Check
  - No transfer switch – Parallel Swgr
  - Grid supplies supplemental power
  - NFPA 70
  - NEC 705 Interconnected Electrical Power Production Sources
  - ANSI / IEEE 242 Protective Devices

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ANSI / IEEE 242 Protective Devices

	Device	Sm	Med	Lge
51 V	Bk-up overcurrent	X	X	X
51 G	Bk-up grd time overcurrent	X	X	X
32	Rev power anti-motoring	P	X	X
40	Rev VAR relay loss of field	P	X	X
87	Diff high speed	P	X	X
87G	Grd Differential			X
46	Negative phase sequence		X	X
49	Stator winding temp			X
64F	Generator field ground			X
60	Voltage balance		X	

Note: Large & Medium may require synch-check or parallel switchgear

Examples: Beckwith M-3401A Protection Relay
Tyco SPR Protection Relay

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Distributed Technologies

	Status	Size	CYCLE Eff. (%)	Installed Costs ($.kw)	Total Cost ($/kwh)
Steam Turbines	Commercial Avail.	50 kw – 200 mw	12 – 38	400 - 1000	0.03 – 0.06
Reciprocating Engine	Commercial Avail.	20 kw – 20 mw	28 – 38	500 - 1400	0.06 – 0.09
Combustion Turbines / CC	Commercial Avail.	500 kw – 500 mw	21 – 65	600 - 900	0.04 – 0.08
Microturbines	Commercial Avail.	30 kw – 300 kw	20 – 28	600 - 1000	0.06 – 0.10
Fuel Cells	Commercial Avail.	5 kw – 3 mw	36 - 60	1900 - 3500	0.06 – 0.10
Photovoltaics	Commercial Avail.	1 kw +	10 - 20	5000 - 10000	0.10 - 0.20
Wind Turbines	Commercial Avail.	750 kw +	13 MPH plus	1000 - 1500	0.10 - 0.20

Note: Total Cost based on 15 % After Tax IRR
Wind Includes Land

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DER Technology Considerations

- Different operating characteristics
  - Diesels, steam turbines, and gas turbines
    - » Large massive rotors
    - » Demand ride through

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- DER Technology Considerations
  - Microtubine, Fuel Cells, & Solar
    - » Light wieght, high speed
    - » Slow response to demand change

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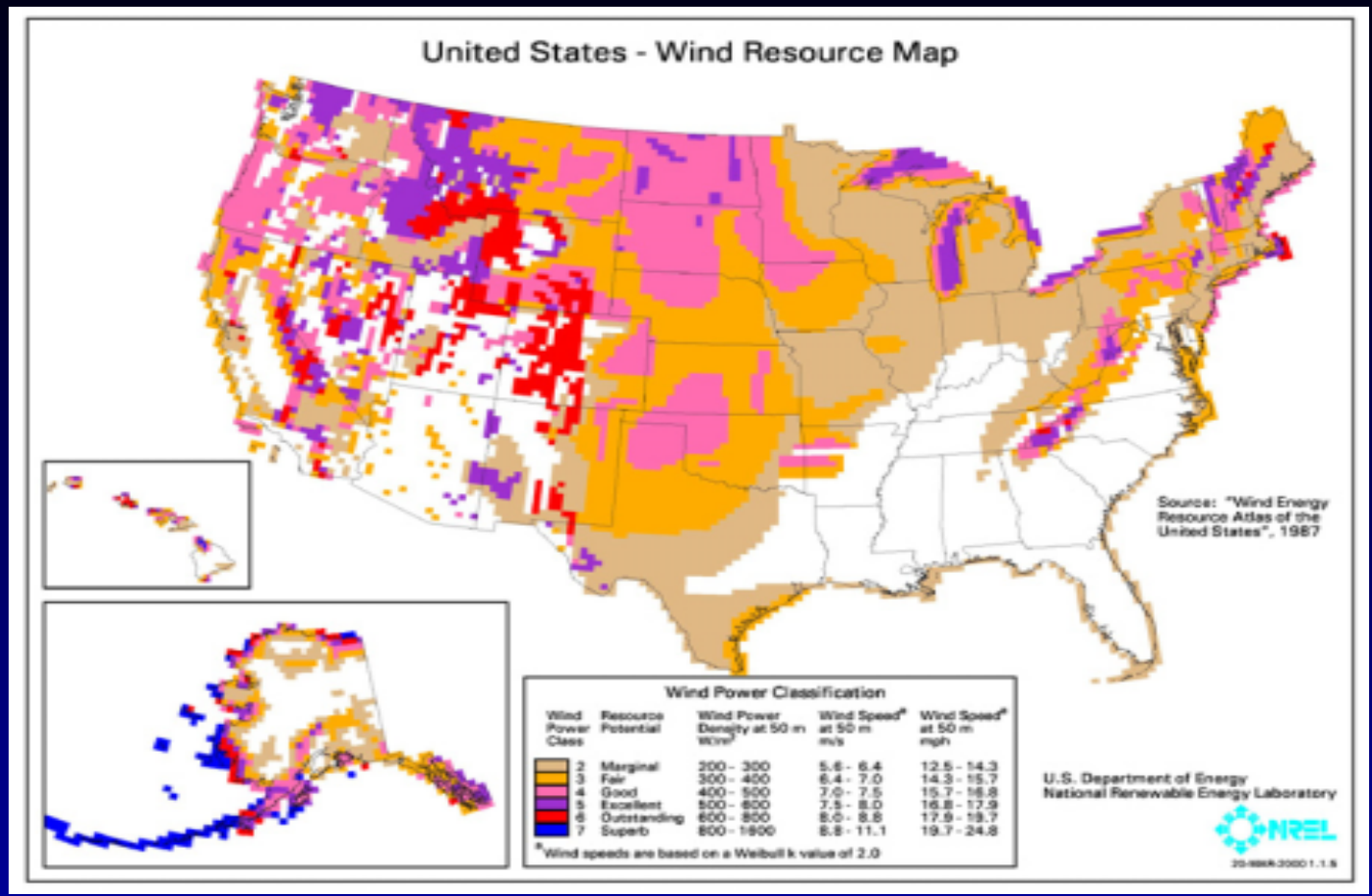
DER Technology Considerations
Wind Turbines Require Wind – Ave 13 MPH



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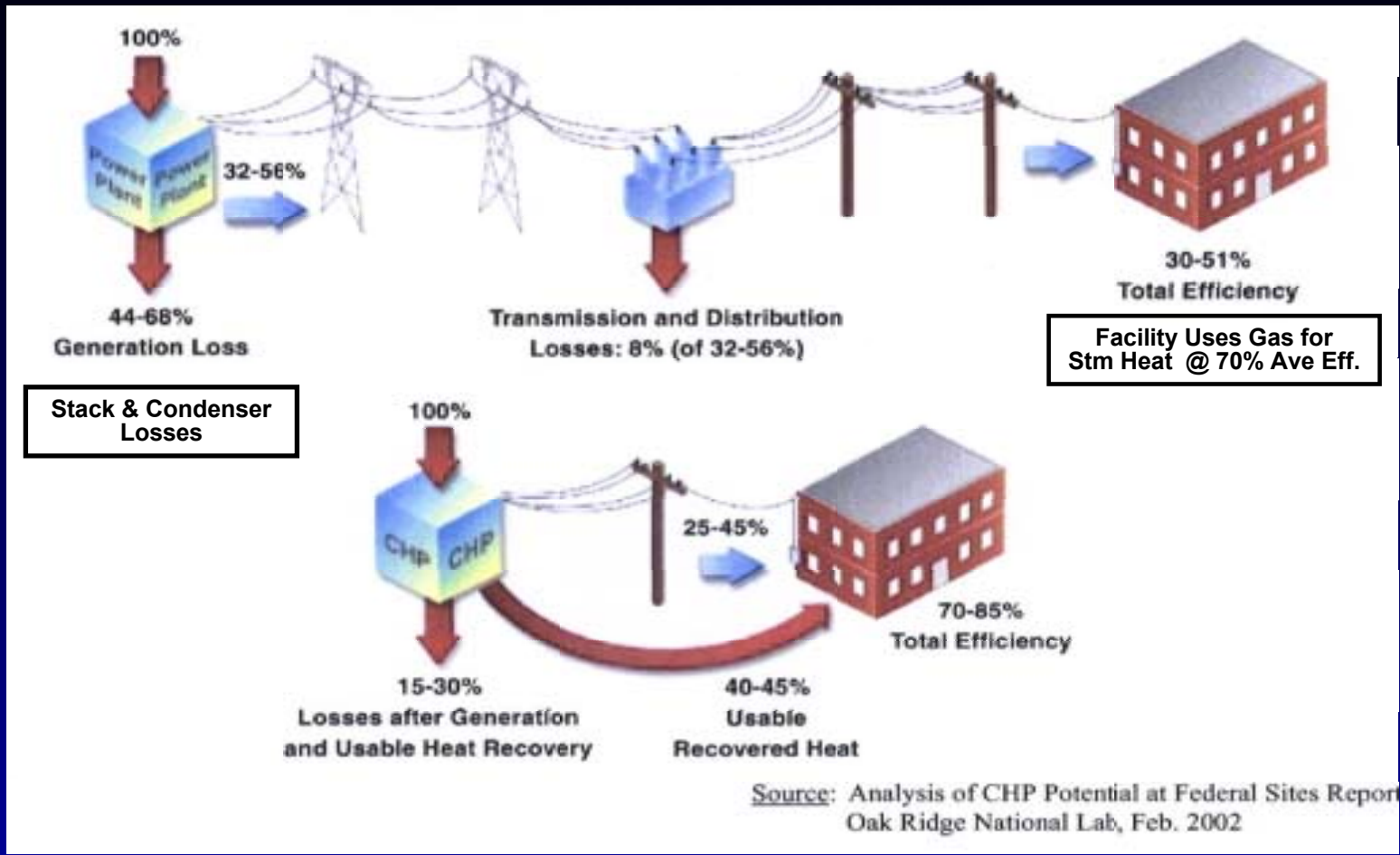
Distributed Energy Resources

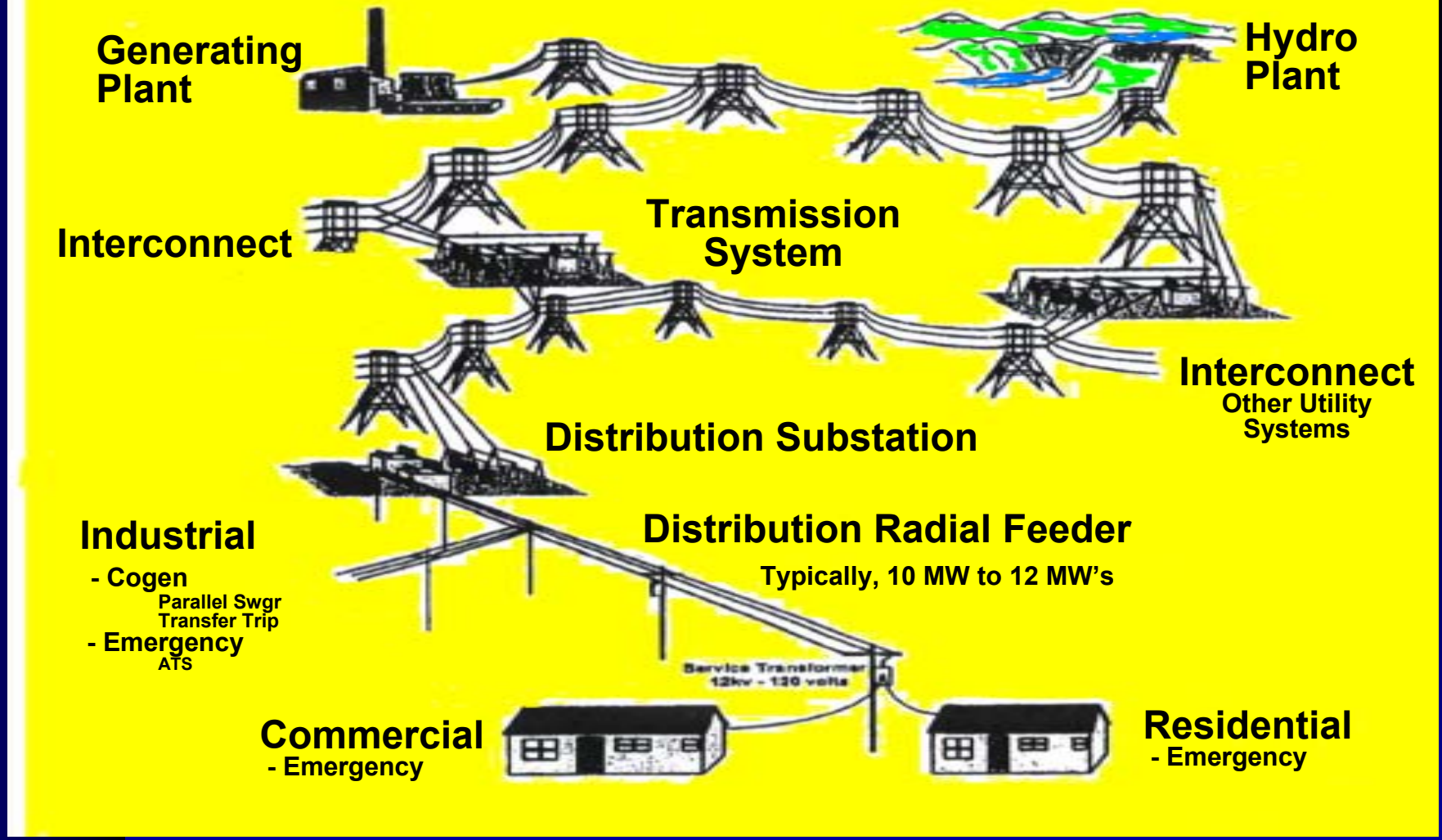
VALUE OF DISTRIBUTED GENERATION
COST, EFFICIENCY, ENVIRONMENT



Source: Analysis of CHP Potential at Federal Sites Report
Oak Ridge National Lab, Feb. 2002

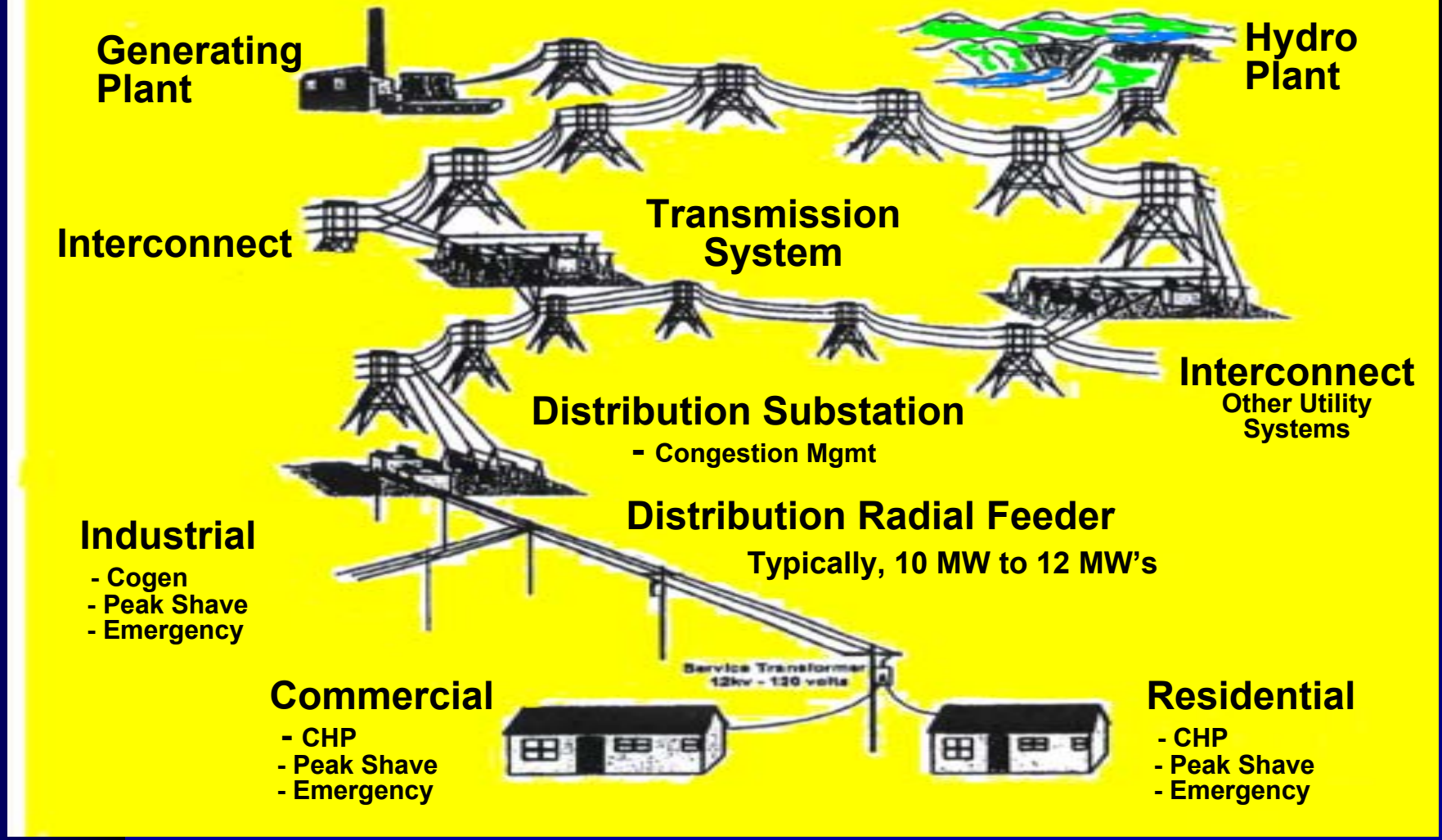
Today's Electric Grid

Distributed Energy Resources



Tomorrow's Electric Grid

Distributed
Energy
Resources



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Issues / Concerns

- Utility Concerns
  - Safety
    - Islanding
    - High Impedance Fault
  - Reliability
  - Stability
  - Integrity
  - Investment Recovery

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Issues / Concerns

- DG Industry Concerns
  - Level Playing Field
  - Reduce high cost of interconnection
  - Certification for standard units
  - Standard Interconnect Requirements
  - Standard Interconnect Agreements
  - Access to Wholesale & Retail Markets

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Issues / Concerns

- Resolution Activities
  - IEEE P1547
    - New Standard
    - Generators less than 10 MW
    - Addresses Inverter Systems
    - Status - Final Process
  - FERC - Standard Market Design
    - Interconnection Agreement
    - Size based – 10 MW's or less
    - Recognizes UL Certification
    - No More than 10% - 15% of circuit capacity

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New Standards

- IEEE P1547 – Interconnecting Distributed Resources with Electric Power Systems
- UL 1741 – Static Inverters and Charge Controllers for Use in Photovoltaic Power systems
  - Will incorporate IEEE P1547 in next revision
- IEEE P1589 – Conformance Test Procedures for P1547 (standard)
- IEEE P1608 – Application for P1547 Installations (guide)
- IEEE P1614 – Guide for Monitoring and Info Exchange (guide)

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Related Interconnection Standards

- NFPA 70 – National Electrical Code (standard)
- UL 891 and UL 1558 – Paralleling Switchgear (standard)
- ANSI / IEEE 242 Protective Devices

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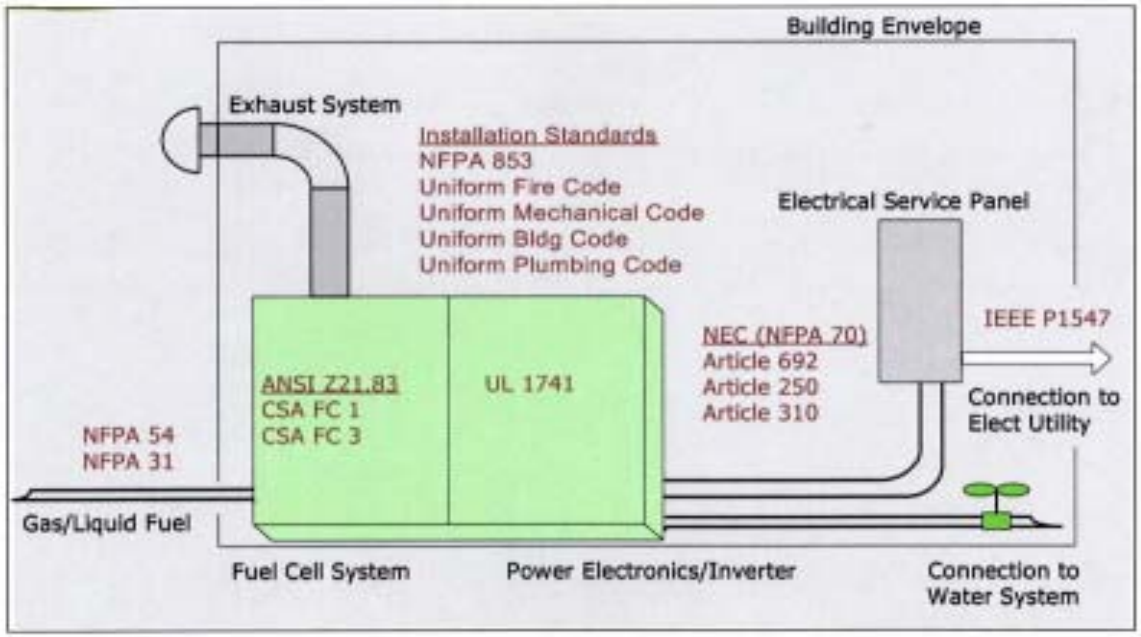
FUEL CELL INSTALLATION

TYPICAL CODES



New Standard

Source: DOE Roadshow, Neil Rossmeissl Codes & Standards Program

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Summary

- DER not a new concept, new technologies
- Different operation modes different standards
- Multiple technologies, different roles
- Changing electrical grid
- Changing grid rules
- Changing standards
  - FERC – SMD Standard Interconnect Agreement
    - Reduces 3,000 utilities, 3,000 Different Agreements
  - IEEE P1547 – Inverter Systems (PV, FC, MT)
    - Resolves “Islanding” Issue
    - Provides Certification